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Bhopal disaster is a worst Chemical industrial accident in Indian history: a short review

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Abstract

The Bhopal disaster was a human-generated Chemical disaster occurred on December 3, 1984, in the Indian city of Bhopal, Madhya Pradesh state, India. It killed an estimated 15,000 to 20,000 people. It is a worst Chemical industrial accident in Indian history. In this article, we present what happened and why and what actions were taken by Governments.

Keywords: Disaster, Industrial, Accident, Chemical

Introduction

Disaster is a sudden accident or a natural catastrophe that causes great loss of human life or destruction of the natural environment, private property, or public infrastructure [1-2]. A disaster may be relatively sudden, such as an earthquake or an oil spill, or it may unfold over a longer period, such as the effects of an ongoing pandemic or climatic disruption. Disasters are two types natural or human-generated. Severe droughts, forest fires, floods, landslides, heat waves, lightning, tsunamis, winter precipitation and volcanic eruptions are often considered examples of natural disasters [3]. Large industrial accidents, building collapses, high-rise fires, airliner crashes, ship sinkings, war and acts of terrorism are frequently classified as human-generated disasters [4].

In India, Bhopal disaster was a man-made Chemical disaster. On December 3, 1984, more than 40 tons of methyl isocyanate gas leaked from a pesticide plant in Bhopal, Madhya Pradesh state, India, immediately killing at least 3,800 people and causing significant morbidity and premature death for many thousands more [5]. At the time, it was the worst Chemical industrial accident in Indian history.

Establishment of Plant in Bhopal

In 1968, Government of India approved 'Union Carbide India Limited' (UCIL) plans to build fertilizer/pesticide formulation plant in Bhopal. The State of Madhya Pradesh leased land in the Kali Parade area of Bhopal for the plant to UCIL on a 99-year lease in an area zoned for

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industrial use. The area around the plant was relatively unpopulated. There were two lakes nearby and the main Bhopal railroad station was about 2 miles from the plant site. Total population of City of Bhopal is estimated to be about 300,000 [6].

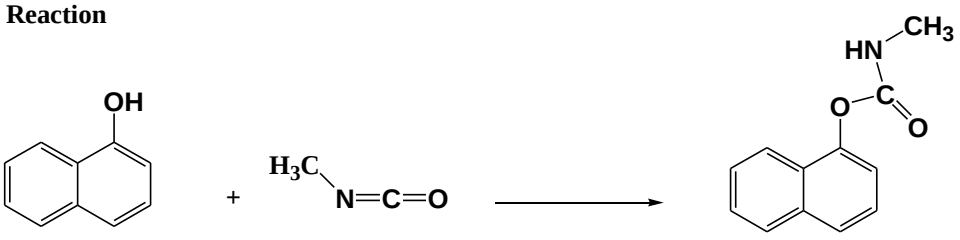
In 1969, action of Bhopal plant was started by UCIL, a Pesticide Company. The production facility was added in 1979. The plant produced SEVIN, a pesticide for use in India to help the country's agricultural sector increase its productivity and contribute more significantly to meeting the food needs of one of the world's most heavily populated regions [7].

The Chemistry of Sevin

Sevin is a pesticide, Chemical name Carbaryl, a white crystalline solid. It is used to control a wide variety of insects and is commonly applied to agricultural sector, mainly plants, trees, soil etc.

Sevin is often cheaply produced by direct reaction of methyl isocyanate, a poisonous gas with α-naphthol [8].

Reaction



1- Napthol **Methyl isocyanate** **Carbaryl**

Liquid MIC and its storage Capacity in Bhopal plant

Methyl isocyanate (MIC) is a volatile, colourless liquid that is extremely flammable and potentially explosive when mixed with air. MIC reacts with moisture (water), giving off heat and producing methyl amine and CO_2 gas. The liquid and papour are toxic when inhaled, ingested or exposed to eyes or skin [9].

There were three liquid MIC storage tanks, E610, E611, and E619 in Bhopal plant (See Fig 1). The maximum MIC storage capacity was 68,000 litre (68 ton) [10]. UCC safety regulations specified that no one tank should be filled more than 50% (about 30 tons) with liquid MIC. Each tank was pressurized with inert nitrogen gas. This pressurization allowed

liquid MIC to be pumped out of each tank as needed and also kept impurities and moisture out of the tanks [10].

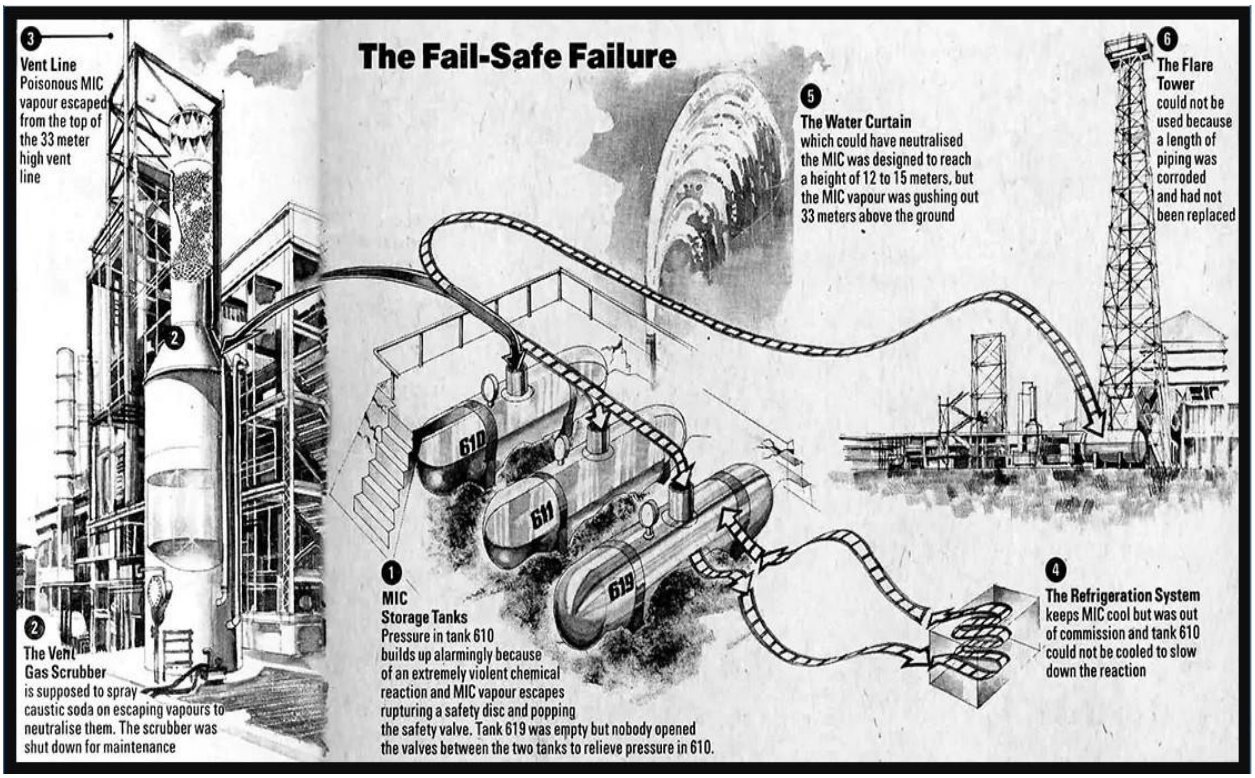


Fig 1: Schematic diagram of Bhopal plant. (Taken from: https://www.indiatoday.in/magazine/ 31-12-1984)

Leakage of gas at the fatal night

During the late evening hours (11.45 pm) of 2 December 1984, workers in the plant realised there was an MIC leak somewhere: their eyes began to tear. A few of them walked around the MIC structure and spotted a drip of liquid about 50 feet off the ground and some yellowish-white gas accompanying the drip. They told Shakil Qureshi, the supervisor on duty, about the Leak. Qureshi, however, decided to deal with the leak after the tea-break, scheduled for 12.15 am. But by the time the tea-break ended at 12.40 am, events were moving very fast. The temperature gauge on tank 610 had reached 25°C, the top of its scale, and pressure was rapidly moving towards 40 psi(280 kilopascals), the point at which the emergency relief valve opens. The pressure in tank E610 got increased 40 psi to 55 psi within 2 hours and the safety valve had opened releasing MIC from the storage tank [11]. About 30 tonnes of MIC

escaped from the tank into the atmosphere in 45 to 60 minutes. This would increase to 40 tonnes within two hours. The gases were blown in a southeast direction over Bhopal [11].

Effects of Disaster

Thousands of people had died by the following morning. Primary causes of deaths were choking, reflexogenic circulatory collapse, and pulmonary oedema. Findings during autopsies revealed changes not only in the lungs but also cerebral oedema, tubular necrosis of the kidneys, fatty degeneration of the liver, and necrotising enteritis [12]. The final death was estimated to be between 15,000 and 20,000. About 3000 animals were killed at that night. The trees died after a few days. Food supplies have grown insufficient due to the fear of contamination. Fishing was also prohibited [13]. Some half a million survivors suffered respiratory problems, eye irritation or blindness, and other maladies resulting from exposure to the toxic gas [14].

Mains Reasons for the Bhopal Gas Tragedy

1. During the buildup to the spill, the plant's safety mechanisms for the highly toxic MIC were not working.
2. Many valves and lines were in disrepair due to rusting, and many vent gas scrubbers were not working properly.
3. The MIC was stored in three tanks, 42 tons of MIC was stored in tank E610 which was greater than safety regulations.
4. Water is believed to have entered the tank through a side pipe as technicians were attempting to clear it late that fatal night. This resulted in an exothermic reaction in the tank, progressively raising the pressure until the gas was ejected through the atmosphere.
5. Refrigeration system was shut down.
6. Most of the workers were incompetent..
7. The alarm off tanks of the plant had not worked properly.

Action of Government

The Government of India paid rupees, 10,000 (U.S.$800 at 1984 rate) for each dead individual and approximately $100 for each hospitalized member of the family. The Government of India sanctioned Rs. 102.00 crores for immediate relief and rehabilitation and

financial assistance to the victims of Gas Tragedy from 1985 to 1989. In 1990, Government of India approved a 5 year Action Plan of the State Government of Madhya Pradesh with a total outlay of Rs.258.00 crores for Medical, Economic, Social and Environmental rehabilitation of Bhopal Gas Victims. It was decided that the expenditure on 5 years Action Plan to be implemented by State Government of Madhya Pradesh would be shared by the Government of India and State Government of Madhya Pradesh In ratio of 75:25. This Action Plan was extended up to July, 1999. The Central Government has already released its entire share of Rs. 193.50 crores and the Action Plan has been completed In the year 1999-2000. Yet, the fund was not enough for victims.

Legal Action

Lawsuits were filed against UCC in the US federal court. In one lawsuit, the court suggested UCC provide between $5 million and $10 million to help the victims. UCC agreed to pay $5 million. But the Indian government refused this offer and claimed $3.3 billion.

An out-of-court settlement was reached in 1989 when UCC agreed to pay $470 million for damages caused and paid the sum immediately.

Civil and criminal cases were filed in the District Court of Bhopal, India, involving UCC and Warren Anderson, UCC CEO at the time of the disaster [15]. In June 2010, seven former employees, including the former UCIL chairman, were convicted in Bhopal of causing death by negligence and sentenced to two years imprisonment and a fine of about $2,000 each, the maximum punishment allowed by Indian law. An eighth former employee was also convicted, but died before the judgement was passed. Anderson died in 2014 never having faced trial.

Conclusion

Bhopal Gas Tragedy continues to be an important warning sign for industrialization, for developing countries like India, with human, environmental, and economic pitfalls. The economy of India is growing at a fast rate but at the cost of environmental health as well as public safety. Far more remains to be done for public health in the context of industrialization to show that the lessons of the countless thousands dead in Bhopal have truly been heeded.

Acknowledgments

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